COURSE DETAILS

" PRECISION IRRIGATION SYSTEMS AND SENSING TECHNOLOGIES"

DEGREE PROGRAMME: PRECISION LIVESTOCK FARMING

ACADEMIC YEAR 2025-2026

GENERAL INFORMATION – TEACHER REFERENCES

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GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE: U2583 - DIGITAL MAPPING AND PRECISION IRRIGATION
MODULE: U2585-PRECISION IRRIGATION SYSTEMS AND SENSING TECHNOLOGIES
SSD OF THE MODULE: AGRI-04/A AGRICULTURAL, FORESTRY AND BIOSYSTEM ENGINEERING (EX 07/C1 AGRICULTURAL, FORESTRY AND BIOSYSTEM ENGINEERING D.M. 855/2015)
TEACHING LANGUAGE: ENGLISH
CHANNEL:
YEAR OF THE DEGREE PROGRAMME: I
SEMESTER: I
CFU: 5

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

None

PREREQUISITES (IF APPLICABLE)

There are no prerequisites.

LEARNING GOALS

The course aims at providing students with advanced notions related to soil and its key properties, the analysis of the spatial variability of environmental information with particular emphasis to soil properties and characteristics, also by means of data manipulation to build models of spatial interpolation. Further, it is provided students with the basic notions related to data retrieval, geospatial visualization and analysis, land evaluation.

Moreover, this course aims to provide students with the advanced concepts for managing precision irrigation at the farm scale. The roles of the three main components covered in this module—soil, plant, and atmosphere—will be illustrated with practical examples.
The course will clarify the function of the soil, including its primary physical and hydraulic characteristics and the main processes of water movement. It will also examine the impact of key agro-meteorological variables on the water consumption of major forage crops grown nationally and worldwide.
Specific focus will be placed on the quantitative assessment of crop water requirements and the use of sensors for the precision management of irrigation operations.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

Upon completion of the course, the student will have acquired the knowledge and understanding required for the management of precision irrigation at the farm scale. They will be able to make sound and autonomous technical decisions, based on an understanding of the following topics:
Fundamentals: soil water balance, crop evapotranspiration, and the calculation of net and gross irrigation requirements.
System Components: farm-scale water balance and main irrigation systems for forage crops.
Strategic Management: decision-making criteria for planning and managing irrigation at the farm scale.
Technology and Automation: Control systems for sprinkler and drip irrigation systems.
Tools and sensors for monitoring the Soil-Plant-Atmosphere Continuum (SPAC), Decision Support Systems (DSS) for irrigation scheduling.
Furthermore, the student will be able to critically analyze and connect the different topics, identifying cause-and-effect relationships and the key processes that govern precision irrigation. This ability will enable them to develop complex syntheses and propose original solutions to specific problems in the field.
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Applying knowledge and understanding

Upon completion of the course, the student will be able to apply the acquired knowledge to solve practical problems related to irrigation management. Specifically, they will be able to:
Analyze Data: Acquire, manage, and analyze agro-meteorological data using spreadsheets to process key statistical indices.
Calculate Water Requirements: Calculate reference evapotranspiration (ETo) using different methods, such as the FAO Penman-Monteith equation and the Hargreaves-Samani approach.
Estimate crop evapotranspiration (ETc) and determine the irrigation requirement at the farm scale.
Design Irrigation Management: Evaluate the efficiency of an existing irrigation system.
Design an irrigation management plan, including automated strategies, based on the soil water balance and the use of specific sensors.
Use Advanced Tools: Interpret and apply recommendations from advanced irrigation advisory services to optimize on-farm strategies.

COURSE CONTENT/SYLLABUS

FRONTAL LESSONS	HOURS
What is irrigation and why is it important? Irrigation systems for forage crops. Irrigation water balance at the farm scale.	*4*
Soil-water relations. Infiltration and drainage.	*3*
The evapotranspiration process. Factors affecting evapotranspiration.	*4*
Reference evapotranspiration (ETo). Meteorological data for calculating reference evapotranspiration.	*4*
The FAO Penman-Monteith equation – Calculation procedure.	*3*
The Hargreaves-Samani method for reference ET – Calculation procedure.	*4*
Crop evapotranspiration under standard conditions. The crop coefficient approach. Factors affecting the crop coefficient.	*3*
Net and gross irrigation requirements. Methods for irrigation scheduling.	*4*
Irrigation scheduling based on the soil water balance.	*4*
Tools and technologies for data collection in the Soil-Crop-Atmosphere Continuum: weather, soil water content, remote sensing.	*3*
Vegetation indices for assessing crop status.	*2*
Tools and technologies for the decision-making process in irrigation scheduling. Web-based advisory services.	*2*
TOTAL	**40**

PRACTICAL TEACHING	HOURS
Irrigation Management Software for Livestock Farms	*4*
Installation of an agro-meteorological station for farm-scale irrigation management	*2*
Soil sampling and laboratory analysis to determine key hydraulic properties for irrigation management	*2*
Field trip to a farm using innovative irrigation systems	*2*
TOTAL	**10**

READINGS/BIBLIOGRAPHY

Crop evapotranspiration - Guidelines for computing crop water requirements - FAO Irrigation and drainage paper 56
Lecture notes provided during the course.
Scientific papers recommended during the course.
Online audiovisual and outreach materials from environmental platforms (e.g., Copernicus, ISAC-CNR, ISPRA).
The HYDRUS-1D Software Manual.

TEACHING METHODS

The teaching will be delivered through a combination of lectures (approximately 80% of the total hours) and practical sessions (approximately 20%). The practical sessions are designed to deepen the understanding of theoretical concepts through hands-on applications, including the use of water balance software for irrigation management.
The teacher will use a student-centered method; tutorials; Practical lessons, learning by doing method. The lessons will be supported by multimedia teaching material available to students on the teacher's website, after registering for the course

EXAMINATION/EVALUATION CRITERIA

*For **integrated courses**, this field should encompass all modules, with indication of the relative weight of each module on the final mark. For integrated courses, this field should be coordinated by the reference teacher for the course.*

a) Exam type:

*For **integrated courses**, there should be one exam.*

Exam type

written and oral	
only written	
only oral	X
project discussion	X
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	
	Numerical exercises	

(*) multiple options are possible

b) Evaluation pattern:

The exam consists of the discussion of a project report and an oral test comprising four questions. The final grade will be a weighted average based on the credits (CFU) for each module of the integrated course. The final grade will therefore be composed as follows: 50% from the "Digital Mapping, Geospatial Statistics and Decision Support" module (5 CFU) and 50% from the "Precision Irrigation Systems and Sensing Technologies" module (5 CFU). For the evaluation, the "Regulation for Guidelines_for_exams_management" approved by the Didactic Coordination Committee of the Master Degree in Precision Livestock Farming will be considered.